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Effects of Alkalinity and Ocean Acidification on Clam Shell Development in Phippsburg, ME

Bailey Moritz, Class of 2016

With increased CO₂ in the atmosphere from the burning of fossil fuels, more is absorbed into the surface ocean, causing a reaction that leads to lower pH. This process is known as ocean acidification, which has raised global concern. Over the past decade, the clam flat near Head Beach in Phippsburg has been reduced to approximately a sixth of its former productive area. The town of Phippsburg allots money every spring to seed the clam flat with juvenile soft-shell clams (*Mya arenaria*) in order to support the local clamming economy, but the clams are no longer growing in much of the mud flat. A possible explanation for this loss is acidification. In order to understand if ocean acidification is the cause, I collected water samples from the mud to test for alkalinity along a transect of 5 sites spanning productive and non-productive areas of the flat. Alkalinity is a measurement of the water's ability to buffer pH changes. Lower alkalinity could mean that clams would have more difficulty forming their calcium carbonate shells due to dissolution in low pH waters. Combined with the pH measurements gathered by my peer, Lloyd Anderson '16, we were able to calculate aragonite saturation state. Water with a saturation state below 1 is capable of dissolving calcium carbonate (aragonite) shells.

A large portion of this research project was figuring out the best methodology to use for collecting data on the clam flat. The tested water needs to represent that which the clams are actually using while they are embedded in the mud. Additionally, juvenile clams only live in the upper centimeter or so of sediment. We followed methodologies used in past studies in Maine (Green et al 2013). Three pore water samples from each site were extracted and brought back to the lab to be filtered on 7 separate days throughout July. We began sampling 2 hours prior to low tide. I determined alkalinity using an automated titration system. Average alkalinity ranged from 2200-2500 µeq/kg.

The results indicated that there was not a significant difference or pattern in alkalinity or saturation state between productive and unproductive areas of the clam flat (Fig. 1). Error bars in the figure represent variability at each site over the entire study period, while analytical reproducibility was ± 9.04 µeq/L. Large changes were observed merely from one day to another. Coastal ecosystems are complex and variations such as time of day, temperature, or productivity may have influences on the porewater characteristics (Duarte 2013). While ocean acidification does not appear to be the primary driving force behind the clams' decline at this location, the saturation state was consistently quite low (<1) at all sites, between 0.2 and 0.6. This value is much lower than other clam flats in Maine (Green et al 2013). *Mya arenaria* may be exposed to conditions that are not ideal for shell growth. Environmental variations such as sediment type or dissolved oxygen could have coupled with this consistently low saturation state to create an imbalance of productivity within the flat. For example, the finer-grained sediment more typical of the unproductive sites combined with low saturation state may create too many unfavorable conditions for the juvenile clams to survive or remain in the sediment. We do not know if saturation state has always been this low in the past or if it the decline is recent and thus contributing to decreased productivity.

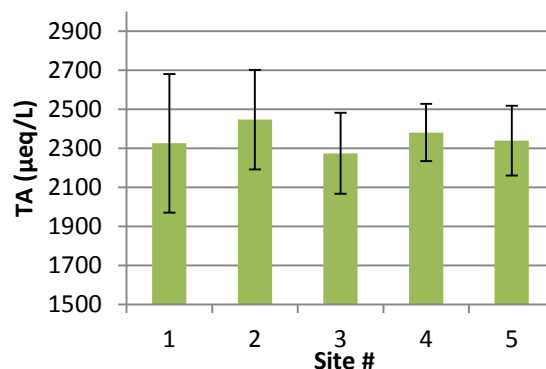


Fig. 1 Alkalinity averaged over all 7 days. Sites 1 & 2 are productive while 4 & 5 no longer have many clams.

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